isolate and identify the toxic elements in them.

SPECIAL ARTICLES

THE GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF SOME PLEISTOCENE MAMMALS

Some months ago Professor Henry F. Osborn, of the American Museum of Natural History, published[1] an important paper entitled "Cenozoic Mammal Horizons of Western North America." Having had occasion recently to consider some phases of the Pleistocene I have examined with interest the part of Professor Osborn's paper devoted to this period.

Professor Osborn has been giving attention to Tertiary history and correlation for many years. In 1900[2] he published his "Correlation between Tertiary Mammal Horizons of Europe and America," in which he devoted eleven pages to a consideration of the Pleistocene. In connection with this he issued a "Third Trial Sheet," in the preparation of which he had the assistance of several European geologists and paleontologists. The paper and the trial sheet dealt more especially with European history. The paper of 1909, put forth after nine years' further investigation on the part of Professor Osborn, during which time numerous other paleontologists and geologists had occupied themselves with Pleistocene studies, presents more fully the American side of the problems.

In Professor Osborn's treatise of 1900 he and his collaborators recognized fully the work that had been done by geologists in their determination of the existence, in Europe, of more than one sheet of glacial accumulations and one or more interglacial deposits. In the communication of 1909, on the contrary, Professor Osborn makes no mention of the great advances that have been made within recent years in the knowledge of the Glacial epoch in North America, resulting in the discovery of four or five distinct glacial sheets and a corresponding number of interglacial deposits of soils, peat beds, gravels and sands, with their organic contents. His bibliography of the Pleistocene (pp. 17, 18) contains no references to such authors as Bain, Calvin, Chamberlin, Dawson, Leverett, Lewis, Salisbury, Tyrrell and others whose works have been of the highest value in the solution of many problems connected with Pleistocene history. And it may be affirmed with confidence that without giving due consideration to glacial geology no correct solution of the paleontology of the Pleistocene is possible.

It appears to have been Professor Osborn's intention to divide the Pleistocene into the Lower, or Preglacial; the Middle, or Glacial, and the Upper, or Postglacial; although he does not mention the last division. We need not here discuss the propriety of recognizing a preglacial stage of a period that has little or nothing to distinguish it from the Pliocene, except the presence of glaciers. On page 87 of Bulletin 361 is a table showing the approximate times of appearance and disappearance of certain important genera of mammals. It is an unfavorable comment on our knowledge of the Pleistocene, when all that can be said of six important genera is that they disappeared at some time during the Glacial period. It is my belief that the history of some of the interesting animals concerned can be determined somewhat more accurately. A beginning will be made with *Equus,* the horses, a genus which Osborn says disappeared from North America during the "upper mid-Pleistocene," a time which unfortunately he does not limit either downward or upward.

If now we indicate on a map all of the apparently authentic finds of fossil horses in the United States east of the great plains, we learn that, starting in New Jersey, one series of localities arranges itself along the Atlantic and the Gulf coasts, while the other, with a few important exceptions, follows an irregular line through Pennsylvania, Ohio, Indiana, Kentucky, Illinois, Missouri, Iowa and South Dakota. A comparison with a map showing the glaciated region of the country indicates that the localities of the last series (barring the few exceptions) are situated close to the southern border of the drift-covered area.

The earliest discovery of fossil horse re-

[1] Bull. U. S. Geol. Surv., 361, pp. 1–90.

[2] *Ann. N. Y. Acad. Sci.,* XIII., pp. 1–64.

mains was made near the Neversink Hills in New Jersey, a considerable distance south of the drift-covered region. Other remains have been found near Philadelphia, likewise south of the drift. Teeth and bones of two species of horses were discovered in Port Kennedy cave, but this too lies south of the glaciated tract. Two teeth of an extinct horse were found in the banks of the Susquehanna River, at Pittston, Pennsylvania, some twenty miles north of the terminal moraine; but Leverett shows by his map[3] that just south of Pittston there is a much older drift sheet. The teeth in question may therefore have been buried in this layer or even below it, in preglacial deposits which may continue north as far as Pittston.

Further west, remains of horses have been found at Cincinnati and at Big Bone Lick. These localities are within the border of the Illinoian drift sheet and possibly the remains are in an interglacial deposit below the drift, inasmuch as at Cincinnati they were obtained several feet below the surface of the drift. Scanty remains of a horse have been discovered near Evansville, Ind.; but this is outside of the glaciated area. The same is to be said regarding two localities in Missouri.

Many years ago Dr. Skilton called attention to some horse teeth that had been found near Troy, N. Y., but there is nothing in the case to make us suppose that they were anything else than the teeth of the domestic horse. Two teeth of a fœtal or new-born horse have been reported by Leidy from Hartmann's cave, near Stroudsburg, Pa. This cave is situated eight or nine miles north of the glacial moraine. Inasmuch as the cave had long been open, so that boys had been accustomed to explore it, the colt teeth may have been rather recently introduced by some carnivorous animal. A more reliable discovery was made many years ago in a bog near the line between Bond and Fayette counties, Ill. From this place Worthen sent to Leidy the maxillary bone, with the four premolars, of a horse which Leidy identified as *Equus complicatus*. Through the kindness of Dr. A. R. Crook, curator of the state museum, at Springfield, I have had the opportunity of examining the specimen and have had the benefit of the expert knowledge of Mr. Gidley. Neither the bone nor the teeth are to any considerable extent mineralized. The teeth have the enamel somewhat more complicated than it is in any known specimen of the domestic horse, but it does not have the thickness indicated in Dr. Leidy's figure of the specimen. The teeth have almost exactly the structure shown in a thoroughly fossilized tooth found at Big Bone Lick and sent by Dr. Crook. The specimen may therefore be regarded as belonging to an extinct horse, probably *E. complicatus*. All that part of Illinois is covered over by the Illinoian drift sheet and since the tooth lay on this drift it must be younger than the Illinoian. It may belong to the Sangamon interglacial deposit. If so, the genus continued to about the middle of the Glacial epoch.

Dr. W J McGee[4] mentioned the finding of a tooth of *Equus complicatus* in northeastern Iowa. In reply to my inquiry Dr. McGee kindly informs me that the tooth was found near Sandspring, Delaware County, Ia., lying on a knoll of Niagara limestone. According to the geological map of this county, the immediate region is covered with Iowan drift, which overlies Kansan drift, but with intervening interglacial gravels and sand. Little of these sheets, except some coarse materials, was left on the wind-swept knoll. In case the tooth had been originally buried in or above the Iowan drift it would hardly have endured the weathering incident to being lowered to the limestone.

Mr. McAdams[5] reported the discovery of a tooth of a horse at the bottom of a well that was being dug in Greene County, Ill. The exact locality was not given. All that region is covered by Illinoian drift. The tooth may have been buried in an interglacial deposit below this. The same writer reported another tooth from Alton, Ill., but no details were given.

[3] Mon. U. S. Geol. Surv., XLI., Pl. II.

[4] Eleventh Ann. Report U. S. Geol. Surv., p. 495.

[5] *Trans. St. Louis Acad.*, IV., p. lxxx.

A remarkable discovery of vertebrate fossils in localities covered over by glacial drift has recently been detailed by Professor Samuel Calvin.[6] Two species of horses, five proboscidians, a camel, mylodon, megalonyx and other extinct mammals are described. The localities are not far from the Missouri River. These remains were buried in the soils belonging to the Aftonian interglacial stage, which preceded the Kansan ice sheet. Therefore, they come to us from near the beginning of the Glacial epoch. It is a fact which may be noted here that, although a large part of Iowa and a part of Kansas are covered by the Kansan drift sheet, which offers facilities for observation and which has been studied closely by geologists for many years, no bones or teeth of fossil horses have yet, so far as I can discover, been found on its surface. Nor have any been found on the surface of the Iowan drift or in it. Nor are there any reliable evidences that remains of horses have been found in those regions that are occupied by glacial deposits belonging to the early and the late Wisconsin stages.

The conclusion reached by the writer from the data at hand is that horses became extinct in the glaciated regions of North America, and probably in the larger part or the whole of the continent, about the middle of the Glacial epoch, the Bond County, Ill., specimen being the only one which indicates with some degree of certainty the existence of the genus *Equus* after the Illinoian stage.

Osborn[7] states that our knowledge of the Lower Pleistocene is still confined to the western plains and mountains, while he regards the fauna of the Port Kennedy cave, in Pennsylvania, as illustrating an early phase of the mid-Pleistocene. Now, 80 per cent. of the mammals of this cave belong to extinct species. The Cromer Forest beds, arranged by Osborn in the Pleistocene, by many authors, as Geikie, Lapparent, etc., in the Pliocene, contain, according to Clement Reid, 45 land mammals, of which 21, or about 46 per cent., are extinct. We might, I think, with reason hold that the mammals of the Port Kennedy cave belong to the Pliocene. There seem to be no good grounds for regarding them as more recent than the fauna of the Equus beds of the Great Plains. Calvin's discovery of the mammals of the Aftonian seems to bring the Equus beds up into the lower part of the Glacial epoch, thus abolishing the Preglacial stage. On the other hand, glaciation in North America may have set in earlier than in Europe. Our Equus beds, though interglacial, may nevertheless be also Pliocene.

We may here consider the probable age of the animals collected by Mr. Barnum Brown in the Conard fissure, Newton County, Ark. Mr. Brown has determined 51 species of mammals, of which 24, or about 47 per cent., are extinct, a ratio almost the same as in the case of the land mammals of the Cromer Forest beds. Evidently they belonged to a much later time than those which perished in the Port Kennedy cave. A few of the species seem to indicate a mild climate; most of them, as the wapiti, the musk ox and several burrowing species, show that the climate was rather rigorous. Evidently some one of the glacial ice sheets had pushed down boreal forms into contact with those of a warmer region. The Kansan ice sheet approached within about 200 miles of the fissure. The time of that sheet seems, however, too remote that more than a moiety of the mammals should yet be with us. It is more probable that those remains were assembled in the fissure during the Illinoian stage. The horse was yet in existence. The absence of the large edentates may be due to their extinction at that time or to their expulsion from the region by the low temperature. The bones and teeth of mammoths and mastodons, which certainly were in existence then, were probably too large to be dragged into the fissure.

There is space to consider only a few of the other genera noted by Osborn. The genus *Cervus* is put down as entering the country late in mid-Pleistocene time. However, the wapiti has been reported from a number of localities, among them Big Bone Lick and the

[6] *Bull. Geol. Soc. Amer.*, Vol. 20, pp. 341–356, pls. 16–27.

[7] Bull. 361, p. 84.

Conard fissure. *Rangifer* is stated by Osborn on page 86 as not appearing in the mid-Pleistocene, but on page 87 as coming in late. According to Shaler, *R. tarandus* seems to have been abundant in the older deposits of Big Bone Lick and a species of caribou has been found at Muscatine, Iowa. The late mid-Pleistocene age of the part of the loess containing the *Rangifer* bones is yet to be proved. *Ursus* is a third genus said by Professor Osborn to be a late comer in glacial times. One or two species of the genus were reported from Port Kennedy cave. Two species of the genus, one not distinguishable by Dr. Leidy from the common black bear, were found near Natchez, Miss., in the loess. Shimek, who has made a special study of the loess at Natchez,[8] says that "the solid blue clay," in which the vertebrates of that section have been found, probably does not belong to the loess, but is older still. How old it is no one knows.

According to the table cited above, the two species of mammoth, *Elephas columbi* and *E. primigenius,* disappeared during the mid-Pleistocene, while the mastodon perished during the "upper mid-Pleistocene." Now, northwestern Ohio, northern Indiana and southern Michigan are deeply covered over by a thick mantle of drift materials that was deposited by the Late Wisconsin ice sheet, the very last of the glacial advances. In depressions left on the surface after the retreat of this sheet there were formed lakes and ponds that afterwards became more or less completely filled up, forming marshes, peat bogs and swales. In ditching such places there have frequently been found the teeth and bones, sometimes nearly complete skeletons of the two elephants and of the mastodon. The fine specimen of *E. columbi,* now in the American Museum at New York and described by Professor Osborn, was found in just such a situation. It would be very difficult to prove that the mastodon survived the mammoth. It is certain that both the elephants and the mastodon continued to inhabit the Mississippi Valley long after the glaciers had abandoned the region and therefore during at least a part, if not the whole, of the Postglacial stage of the Pleistocene.

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[8] *Bull. Lab. Nat. Hist.*, Iowa Univ., V., p. 307.

CATALYTIC ACTION OF IRON SALTS

GIBBS[1] has shown that the red coloration of phenol is due to oxidation brought about by the catalytic action of sunlight. The oxidation products condense and form red substances, as for example, phenoquinone.

As Dr. Fenton has shown that oxygen and sunlight are equivalent to hydrogen peroxide and a trace of a ferrous salt in their oxidizing action upon organic compounds, it struck me that the catalytic action of iron might be studied colorimetrically by resource of Gibb's work.

A concentrated solution of phenol in benzene was divided into three equal parts. The first was exposed to sunlight for two days, the second was treated with a small quantity of hydrogen peroxide, and to the third were added a trace of ferrous sulphate, and then the same quantity of hydrogen peroxide as was added in the second case.

No change could be seen in the first, the second almost immediately developed a very slight pink coloration, but the third at once changed to a reddish-brown color.

Blank experiments were made to show that the color was not due to benzene. Again, in order to prove that the color was not due to the iron alone, traces of a ferrous and a ferric salt were added to a similar benzene solution (without the hydrogen peroxide) when a greenish color was produced, which in no way could be associated with the reddish-brown color caused by iron and peroxide.

Further experiments showed that by means of the above reagents many of the laws of catalysis could be actually demonstrated to a large class in a lecture. More especially because the action was rapid and could be followed by the production of color. For example, to prove in a rough manner that catalysis can not affect the final equilibrium, the two differently colored solutions (one containing traces of iron and the other not)

[1] *Philipp. J. Sci.*, 1909, 4, 133.